

Appl. No. 09/270,780
Amendment After Final dated September 1, 2004
Reply to Office Action of June 1, 2004

IN THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claim 1 (Previously Presented): A liquid crystal display device comprising:

- an illumination device;
- a light control element arranged at a projected light side of the illumination device;
- a reflective polarizer arranged at an upper portion of the light control element so that a polarized light transmission axis of the reflective polarizer is adjusted so as to be substantially perpendicular or substantially parallel to a control axis of the light control element;
- a liquid crystal display element for controlling polarization of projected light projected from the reflective polarizer; and
- a screen arranged at an upper portion of the liquid crystal display element;

wherein the light control element is the only light control element arranged between the illumination device and the reflective polarizer.

Claim 2 (Previously Presented): A liquid crystal display device according to claim 1, wherein the reflective polarizer is arranged so that the polarized light transmission axis of the reflective polarizer is approximately parallel to a major axis direction of a pixel the liquid crystal display element.

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Claim 3 (Previously Presented): A liquid crystal display device
according to claim 2,
wherein the reflective polarizer is composed so as to have a light directivity in
a minor axis direction of the pixel; and
wherein the screen is composed so as to broaden projected light in the minor
axis direction of the pixel.

Claim 4 (Canceled):

Claim 5 (Previously Presented): A liquid crystal display device
according to claim 3, wherein the screen is composed so as to absorb external light
and to transmit the projected light from the illumination device.

Claim 6 (Previously Presented): A liquid crystal display device
according to claim 1, further comprising a birefringent medium arranged between the
illumination device and the light control element.

Claim 7 (Previously Presented): A liquid crystal display device
according to claim 1, wherein the liquid crystal display element includes:
at least a pair of transparent substrates;
a liquid crystal layer interposed between the pair of transparent substrates;
and
a pair of absorption type polarizers arranged so that the pair of transparent
substrates are held between the pair of absorption type polarizers.

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Claim 8 (Previously Presented): A liquid crystal display device

according to claim 1, wherein the illumination device includes:

a flat waveguide having a front plane and a rear plane, the front plane of the waveguide constituting a light projecting plane of the waveguide, the rear plane of the waveguide, having numerous depressed planes, protruded planes, or steps, the depressed planes, protruded planes, or steps having respective slightly declined planes;

a light source arranged adjacent to the waveguide; and

a reflector arranged at the rear plane of the waveguide, the reflector either contacting the rear plane of the waveguide directly, or being spaced from the rear plane of the waveguide via an air layer;

wherein the waveguide and the light source are composed so that projected light from the light source is propagated in the waveguide and projected from the light projecting plane of the waveguide; and

wherein the declined planes of the reflector are mirrors.

Claim 9 (Previously Presented): A liquid crystal display device

according to claim 1, wherein the light control element is any one of an isotropic medium and a uniaxial birefringent medium.

Claim 10 (Previously Presented): A liquid crystal display device

according to claim 7, further comprising a reflective color selective layer corresponding to the pixel of the liquid crystal display element.

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Claim 11 (Previously Presented): A liquid crystal display device comprising:

- an illumination device;
- a light control element arranged at a projected light side of the illumination device;
- a reflective polarizer arranged at an upper portion of the light control element so that a polarized light transmission axis of the reflective polarizer is adjusted so as to increase a transmission rate of a projected light from the illumination device;
- a liquid crystal display element for controlling polarization of projected light projected from the reflective polarizer; and
- a screen arranged at an upper portion of the liquid crystal display element; wherein the liquid crystal display element includes:
 - at least a pair of transparent substrates;
 - a liquid crystal layer interposed between the pair of transparent substrates;

and

- a pair of absorption type polarizers arranged so that the pair of transparent substrates are held between the pair of absorption type polarizers; and
- wherein a half-value width of projected light θ_1 (an angular range wherein a brightness becomes 1/2 of a peak value) from the illumination device in at least a certain direction satisfies a relationship expressed by the following equation:

$$\theta_1 \leq \sin^{-1}(n \cdot \sin(\tan^{-1}(2d/t)))$$

where

- t is a thickness of each of the pair of transparent substrates,

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n is a refractive index of each of the pair of transparent substrates,
and
d is a length of the pixel in a minor axis direction of the pixel.

Claim 12 (Previously Presented): A liquid crystal display device
according to claim 10, wherein the liquid crystal layer, the reflective polarizer, the
absorption type polarizers, and the reflective color selective layer are arranged so
that a stripe direction of the reflective color selective layer coincides with an axis in a
scattering direction of the screen.

Claim 13 (Previously Presented): A liquid crystal display device
comprising:
an illumination device;
a light control element arranged at a projected light side of the illumination
device;
a reflective polarizer arranged at an upper portion of the light control element
so that a polarized light transmission axis of the reflective polarizer is adjusted so as
to be substantially perpendicular or substantially parallel to a control axis of the light
control element;
a liquid crystal display element for controlling polarization of projected light
projected from the reflective polarizer so that a major axis direction of a pixel of the
liquid crystal display element is arranged approximately parallel to a direction in
which a linearly polarized light component of projected light projected from the
illumination device is high; and

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a screen arranged at an upper portion of the liquid crystal display element;
wherein the light control element is the only light control element arranged
between the illumination device and the reflective polarizer.

Claim 14 (Previously Presented): A liquid crystal display device
according to claim 13, further comprising a birefringent medium arranged between
the illumination device and the light control element.

Claim 15 (Previously Presented): A liquid crystal display device
according to claim 13, wherein the illumination device includes:

a flat waveguide having a front plane and a rear plane, the front plane of the
waveguide constituting a light projecting plane of the waveguide, the rear plane of
the waveguide having numerous depressed planes, protruded planes, or steps, the
depressed planes, protruded planes, or steps having respective slightly declined
planes;

a light source arranged adjacent to the waveguide; and

a reflector arranged at the rear plane of the waveguide, the reflector either
contracting the rear plane of the waveguide directly, or being spaced from the rear
plane of the waveguide via an air layer;

wherein the waveguide and the light source are composed so that projected
light from the light source is propagated in the waveguide and projected from the
light projecting plane of the waveguide; and

wherein the declined planes of the reflector are mirrors.

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Claim 16 (Previously Presented): A liquid crystal display device according to claim 13, wherein the light control element is any one of an isotropic medium and a uniaxial birefringent medium.

Claim 17 (Previously Presented): A liquid crystal display device according to claim 13, further comprising a reflective color selective layer corresponding to a pixel of the liquid crystal display element.

Claim 18 (Previously Presented): A liquid crystal display device according to claim 13, wherein the liquid crystal display element includes:
at least a pair of transparent substrates;
a liquid crystal layer interposed between the pair of transparent substrates;
and
a pair of absorption type polarizers arranged so that the pair of transparent substrates are held between pair of absorption type polarizers.

Claim 19 (Previously Presented): A liquid crystal display device comprising:
an illumination device;
a light control element arranged at a projected light side of the illumination device;
a reflective polarizer arranged at an upper portion of the light control element;
a liquid crystal display element for controlling polarization of projected light projected from the reflective polarizer so that a major axis direction of a pixel of the

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liquid crystal display element is arranged approximately parallel to a direction in which a linearly polarized light component of projected from the illumination device is high; and

a screen arranged at an upper portion of the liquid crystal display element;

wherein the liquid crystal display element includes:

at least a pair of transparent substrates;

a liquid crystal layer interposed between the pair of transparent substrates; and

a pair of absorption type polarizers arranged so that the pair of transparent substrates are held between pair of absorption type polarizers; and

wherein a half-value width of projected light θ_1 (an angular range wherein a brightness becomes 1/2 of a peak value) from the illumination device in at least a certain direction satisfies a relationship expressed by the following equation:

$$\theta_1 \leq \sin^{-1}(n \cdot \sin(\tan^{-1}(2d/t)))$$

where

t is a thickness of each of the pair of transparent substrates,

n is a refractive index of each of the pair of transparent substrates,

and

d is a length of the pixel in a minor axis direction of the pixel.

Claim 20 (Previously Presented): A liquid crystal display device comprising:

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an illumination device;

a light control element arranged at a projected light side of the illumination device;

a reflective polarizer arranged at an upper portion of the light control element so that a polarized light transmission axis of the reflective polarizer is so that a polarized light transmission axis of the reflective polarizer is adjusted so as to be substantially perpendicular or substantially parallel to a control axis of the light control element;

a liquid crystal display element for controlling polarization of projected light projected from the reflective polarizer so that a major axis direction of a pixel of the liquid crystal display element is arranged approximately parallel to a direction in which a linearly polarized light component of the polarized light projected from the illumination device is high; and

a screen arranged at an upper portion of the liquid crystal display element;

wherein the light control element is the only light control element arranged between the illumination device and the reflective polarizer.

Claim 21 (Previously Presented): A liquid crystal display device according to claim 20, wherein the illumination device includes a reflector arranged at a rear plane of the illumination device.

Claim 22 (Previously Presented): A liquid crystal display device according to claim 20, wherein the liquid crystal display element includes:
at least a pair of transparent substrates;

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a liquid crystal layer interposed between the pair of transparent substrates;
and
a pair of absorption type polarizers arranged so that the pair of transparent substrates are held between pair of absorption type polarizers.

Claims 23-24 (Canceled):

Claim 25 (Previously Presented): A liquids crystal display device
comprising:

an illumination device;
a light control element arranged at a projected light side of the illumination device;
a reflective polarizer arranged at an upper portion of the light control element so that a polarized light transmission axis of the reflective polarizer is adjusted so as to be substantially perpendicular or substantially parallel to a control axis of the light control element;
a liquid crystal display element for controlling polarization of the projected light from the reflective polarizer; and
a screen arranged at an upper portion of the liquid crystal display element;
wherein the reflective polarizer is arranged so that the polarized light transmission axis is approximately parallel to a major axis direction of a pixel of the liquid crystal display element, and is composed so as to have a light directivity in a minor axis direction of the pixel of the liquid crystal display element; and

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wherein a ratio of a length of the pixel in the major axis direction to a length of the pixel in the minor axis direction is substantially 3:1.

Claim 26 (Previously Presented): A liquid crystal display device as claimed in claim 8,

wherein the declined planes form stripes on the reflector; and

wherein the stripes on the reflector are substantially parallel to a major axis direction of a pixel of the liquid crystal display element.

Claims 27-28 (Canceled):

Claim 29 (Previously Presented): A liquid crystal display device comprising:

an illumination device;

a light control element arranged at a projected light side of the illumination device;

a reflective polarizer arranged at an upper portion of the light control element so that a polarized light transmission axis of the reflective polarizer is adjusted so as to be substantially perpendicular or substantially parallel to a control axis of the light control element;

a liquid crystal display element for controlling polarization of the projected light from the reflective polarizer so that a major axis direction of a pixel of the liquid crystal display element is arranged approximately parallel to a direction in which a

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linearly polarized light component of the projected light from the illumination device is high; and

a screen arranged at an upper portion of the liquid crystal display element;
wherein the light control element is the only light control element arranged between the illumination device and the reflective polarizer; and

wherein a ratio of a length of the pixel in the major axis direction to a length of the pixel in a minor axis direction of the pixel is substantially 3:1.

Claim 30 (Previously Presented): A liquid crystal display device as claimed in claim 15,

wherein the declined planes form stripes on the reflector; and

wherein the stripes on the reflector are substantially parallel to the major axis direction of the pixel.

Claims 31-32 (Canceled):

Claim 33 (Previously Presented): A liquid crystal display device comprising:

an illumination device;

a light control element arranged at a projected light side of the illumination device;

a reflective polarizer arranged at an upper portion of the light control element so that a polarized light transmission axis of the reflective polarizer is so that a polarized light transmission axis of the reflective polarizer is adjusted so as to be

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substantially perpendicular or substantially parallel to a control axis of the light control element;

a liquid crystal display element for controlling polarization of the projected light from the reflective polarizer so that a major axis direction of a pixel of the liquid crystal display element is arranged approximately parallel to a direction in which a linearly polarized light component of the polarized light projected from the illumination device is high; and

a screen arranged at an upper portion of the liquid crystal display element;

wherein the light control element is the only light control element arranged between the illumination device and the reflective polarizer; and

wherein a ratio of length of the pixel in the major axis direction to a length of the pixel in a minor axis direction of the pixel is substantially 3:1.

Claim 34 (Previously Presented): A liquid crystal display device as claimed in claim 21,

wherein the reflector includes numerous declined reflective planes forming stripes on the reflector; and

wherein the stripes on the reflector are substantially parallel to the major axis direction of the pixel.